Thin Cloud Rotating Shadowband Radiometer

Retrieving Particle size and Liquid-water Path from Forward scattering lobe measurements

An Instrument Modification Proposal

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Theory
Proposed Instrument & Deployment Options

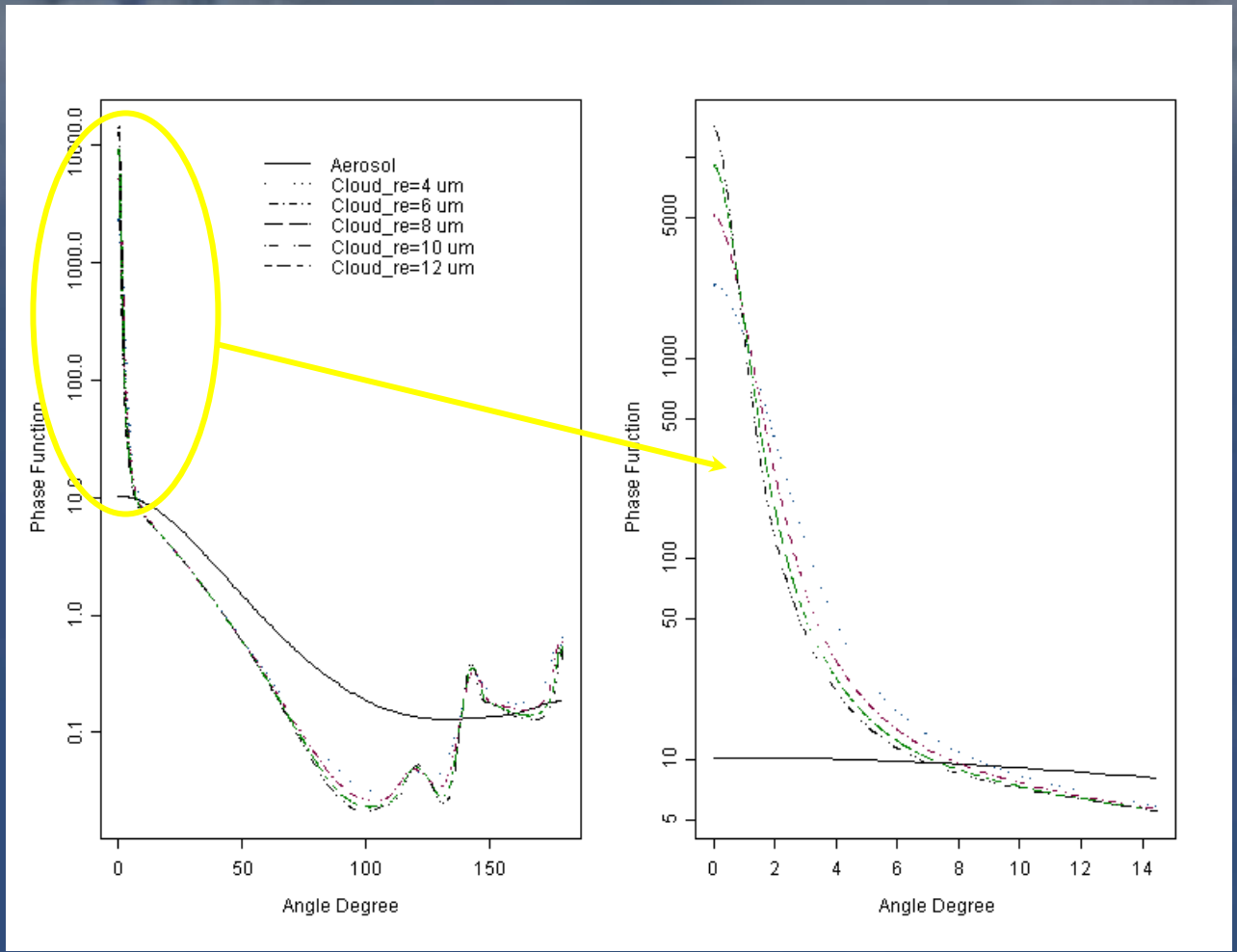
Theoretical Basis

Min, Q., and M. Duan (2005), Simultaneously retrieving cloud optical depth and effective radius for optically thin clouds, *J. Geophys. Res.*, 110, D21201, doi:10.1029/2005JD006136.

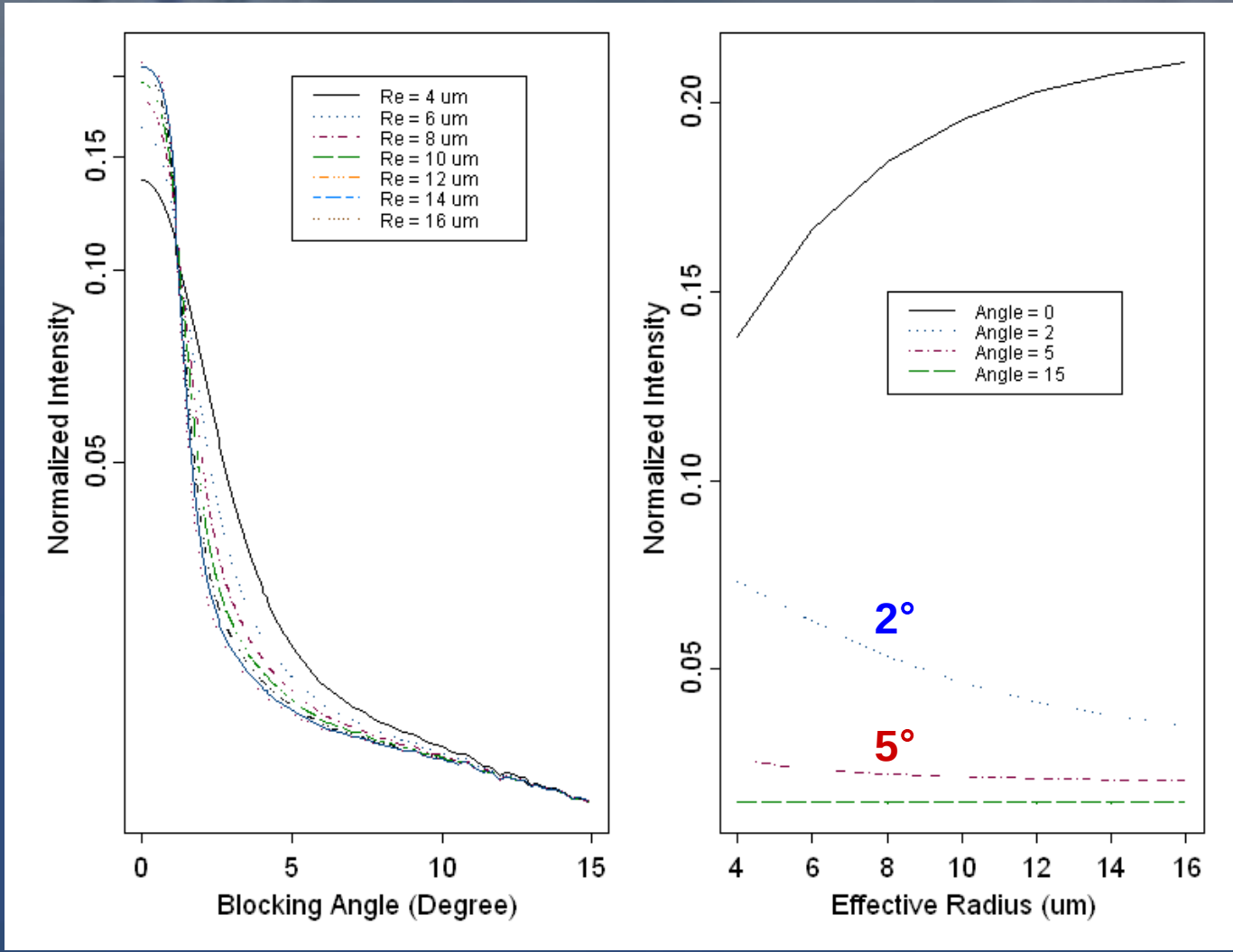
Angle-resolved measurements of the forward scattering lobe (of direct beam) from a thin cloud can be used to retrieve:

- **cloud optical depth**
- **effective radius**
- **liquid-water path**

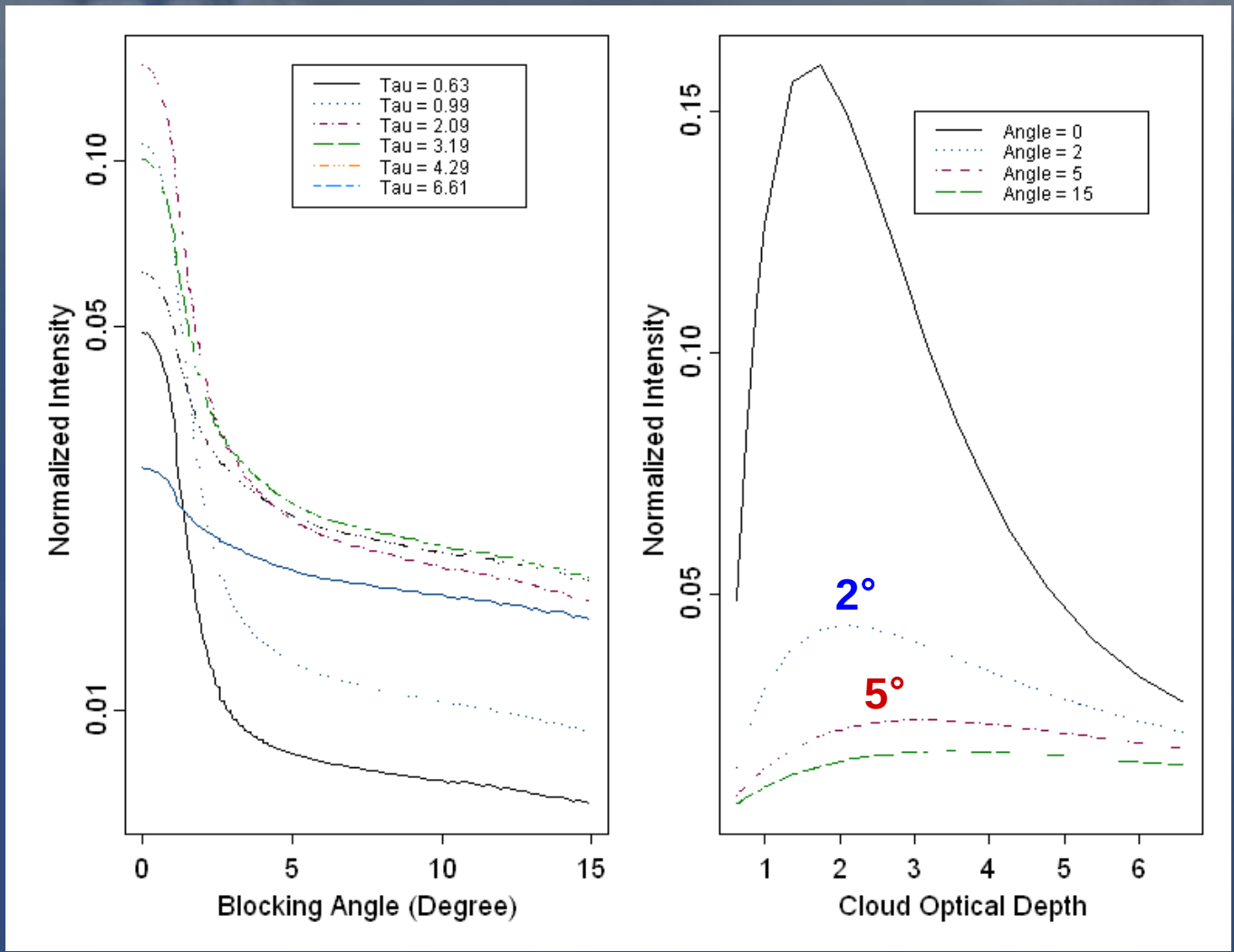
Forward scattering lobe & cloud drop size



Measuring forward-scattering lobe: Effective Radius Sensitivity

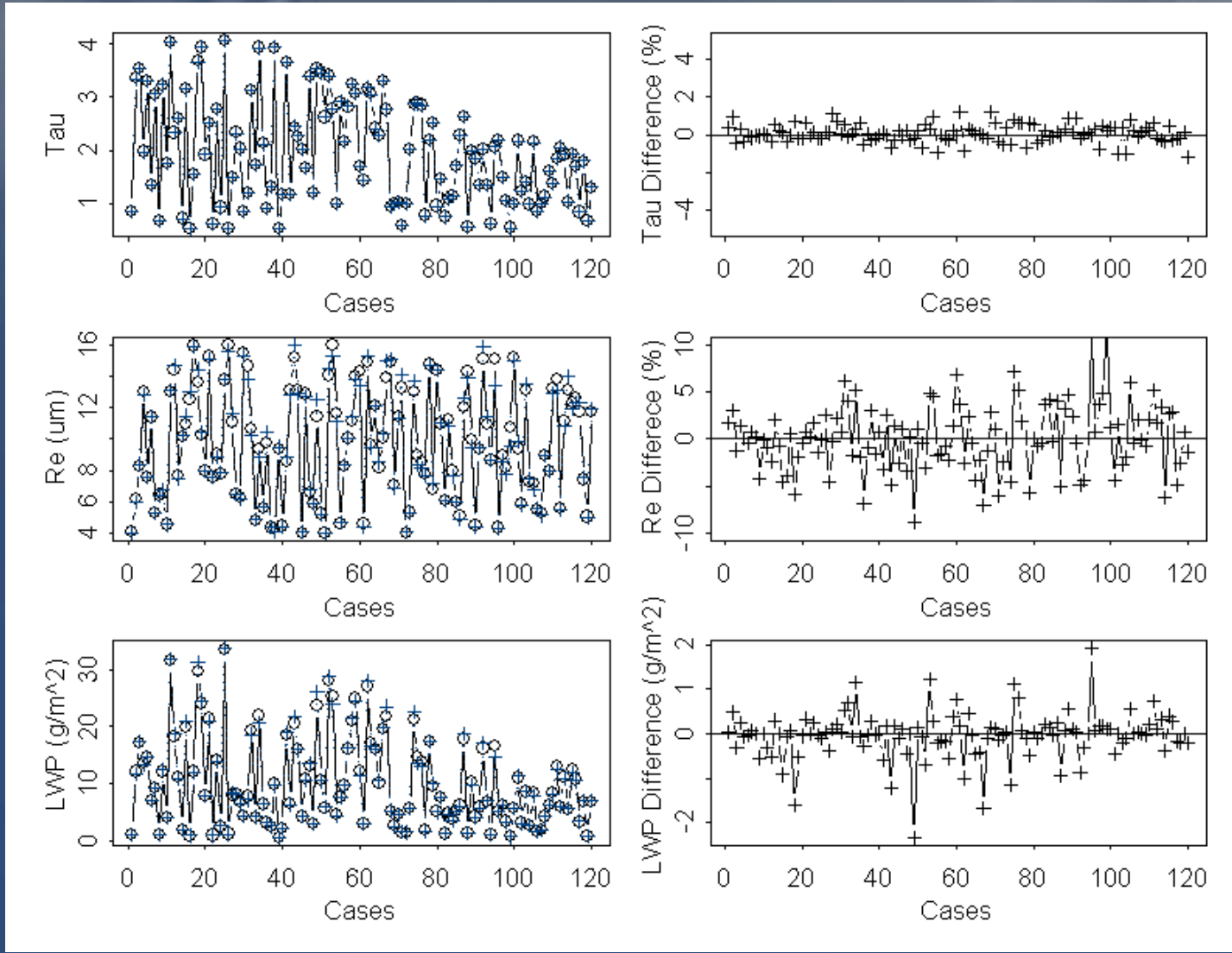


Measuring forward-scattering lobe: Cloud Optical Depth Sensitivity



Simulations: Proof of concept

120 random cases
SZA changes from 25 to 70°



Simulations: Proof of concept results

Retrieval accuracies

Cloud optical depth	2%
Effective radius	10%
Liquid water path	2 gm^{-2}

Improvement possible with oversampling

Desired Measurement Specifications

Blocking angles 2°and, ideally, 5°

Scanning resolution (minimum)

- 1°resolution ± 15° from Sun
- 2°beyond that
- Oversampling better

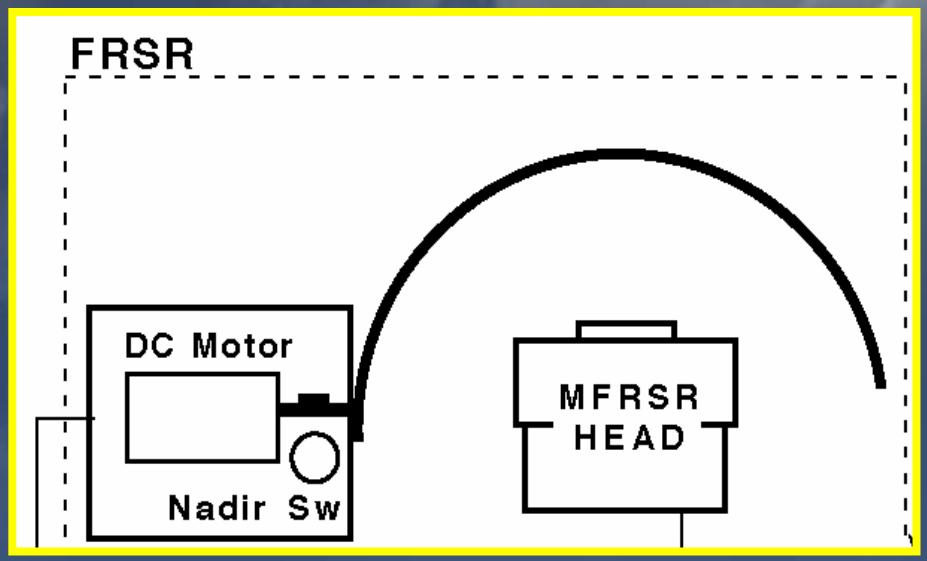
Proposed Instrument Modification

Thin Cloud Rotating Shadowband Radiometer (TC-RSR)

BNL Geophysical Instruments & Measurements Group

Mike Reynolds
Mary Jane Bartholomew
Ray Edwards
Mark Miller
Scott Smith

Fast-Rotating Shadowband Radiometer (FRSR)



References:

Reynolds et al. (*JTECH*, 2001)
Theory & Design

Miller et al. (*JTECH*, 2004)
Accuracy

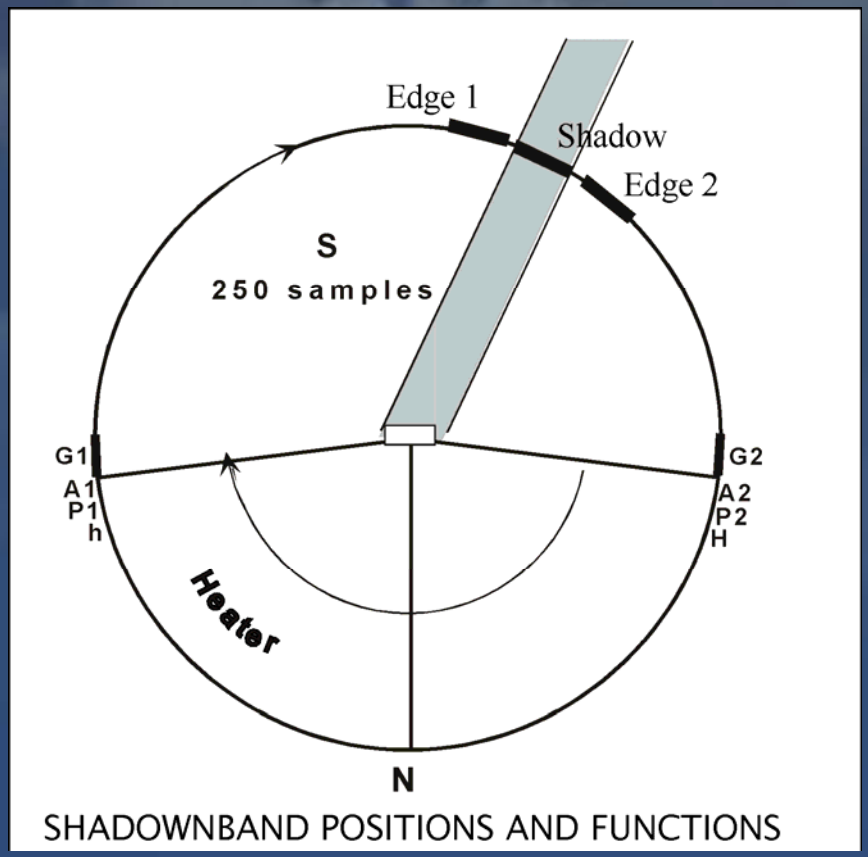
Miller et al., (*Appl. Optics*, 2005)
AOD Intercomparison

Portable Radiation Package
FRSR, PRP, PIR

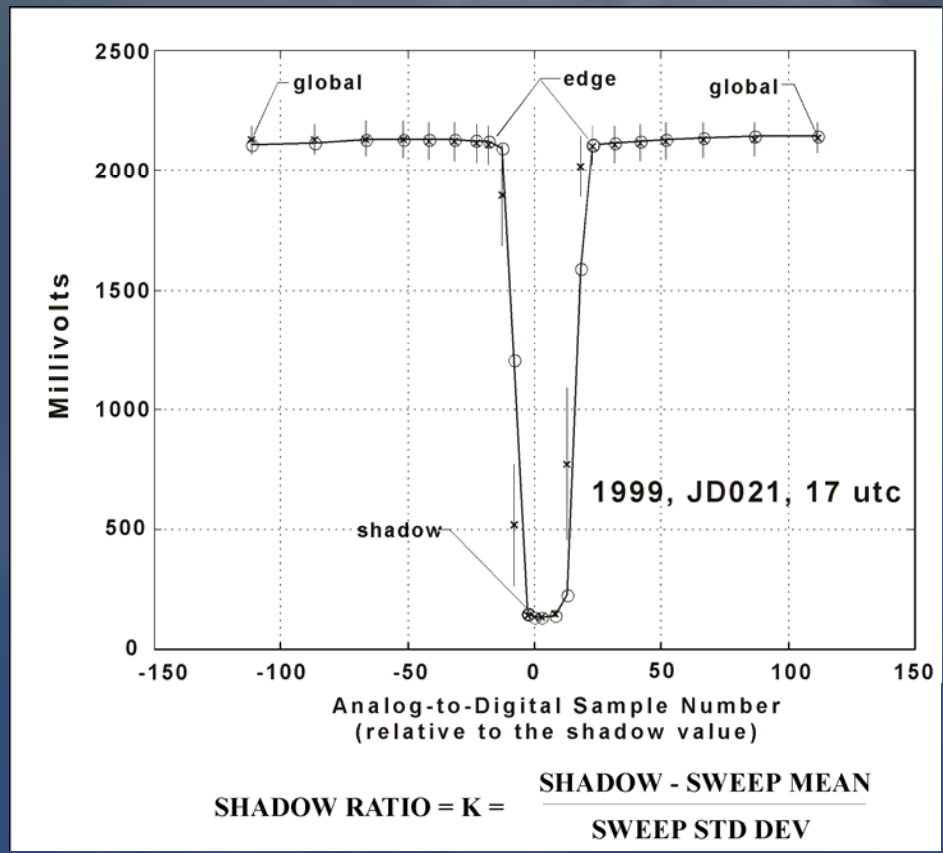
Designed for use on ships
ARM SOAR Program
NASA SIMBIOS

Operations
First in 1999 (Nauru 1999)
12 units built and operated
JAMSTEC 3 cont. for 5 yrs

FRSR Blade Scanning Operation

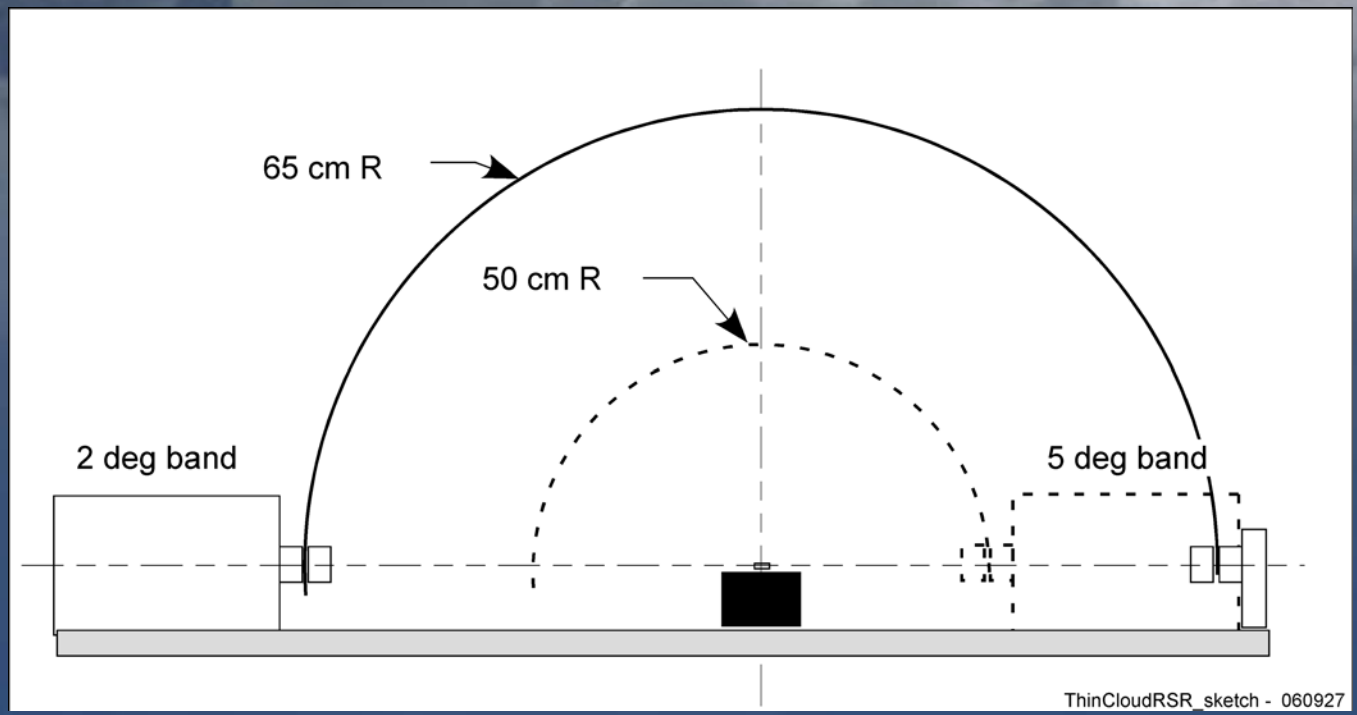


SHADOWNBAND POSITIONS AND FUNCTIONS



$$\text{SHADOW RATIO} = K = \frac{\text{SHADOW - SWEEP MEAN}}{\text{SWEEP STD DEV}}$$

Proposed THIN CLOUD RSR (TC-RSR)



FRSR Modifications

- Two shadowband occultations
  - 2° and 5°
  - 250 samples for each shadowband sweep (<1°)
  - Hemispheric sweep. "Parking" ability.
- Approx 10-sec for a full hemisphere sweep.
- Minimal electronic modifications required

Estimated Modification Cost Options

1) Proof of Concept –
   Land deployment at Mid-Latitude Location
   - Use some existing instrumentation
   - Build modified scanning blades
   - Add motor and reduce their speeds
   - Dump data stream directly to PC (no internal processing)
   - Test setup
   - $25 K (burdened)

2) Ready-to-go first-off instrument –
   Generalized model (Marine capable)
   - Above items, but fabricated anew with software modifications
     - Onboard processing & packing of data
   - $50 K (burdened)

Other costs related to shipping to site or operation on site are not included.

Only minimal documentation is part of this cost.

Schedule

October: Work out design details
November-December: Instrument fabrication in BNL shop.
Jan-Feb: Software development and testing.

Deployment Options

1) COPS (9 months, statistics)
or
2) SGP (CLASIC)

So…

Shall we do this? (yea, nea)

If so, when and where?